FEASIBILITY OF SPRINKLER IRRIGATION IN MONTANA

MARKETING AND MANUFACTURING CENTER PIVOT SPRINKLERS

FEASIBILITY OF SPRINKLER IRRIGATION IN MONTANA:

MARKETING & MANUFACTURING CENTER PIVOT SPRINKLERS

for

Division of Economic Development

State of Montana

by

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Consultants Collaborative

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INTRODUCTION

The purpose of this study is to establish the feasibility of center pivot sprinkler irrigation manufacturing in the state of Montana. Too often, in the view of Consultants Collaborative, various economic enterprises have been proposed in Montana without due regard to markets. Montana's economy is essentially a raw materials economy, distant from markets for manufactured goods. However, Montana is a market for certain manufactured items used in agricultural production. This study is an attempt to chart the market for one of those items - - sprinkler irrigation equipment. And, the study is concerned with determining the feasibility of a Montana plant to manufacture one type of irrigation sprinkler to meet existing and potential demand in that market.

A number of economic factors including national and international demand for food products, irrigation technology and user acceptance of that technology, availability of water resources and water resource planning have combined to stimulate both an interest and activity in sprinkler irrigation in Montana and surrounding states. The extent and rate of sprinkler irrigation activity is unparalleled in Montana history. Moreover, that activity is underway at similar levels in North and South Dakota and to a somewhat lesser degree in the province of Alberta, Canada. The accelerating pace of sprinkler irrigation in Montana and surrounding areas justifies a serious exploration of the feasibility

of manufacturing sprinkler irrigation equipment within Montana.

Consultants Collaborative would like to thank Mr. Lee Heitala and Mr. Joseph Monahan of the Economic Development Division of the Montana Department of Community Affairs, and Mr. Glenn Smith of the Division of Water Resources of the Montana Department of Natural Resources. Special thanks are given to the officals of several sprinkler irrigation manufacturing firms in Washington and Oregon for both their help and candor regarding the economics of the sprinkler irrigation industry and to officials of North and South Dakota and the provinces of Alberta and Saskatchewan, Canada. Consultants Collaborative would also like to thank officals of Montana's Federal Land Bank system.

MARKETING FACTORS

Economic feasibility of sprinkler irrigation equipment manufacturing in Montana depends upon existing or potential markets for sprinkling systems. These markets are, in turn, dependent on the following factors:

1. Availability of technology and advantages of the technology.
2. Acceptance of sprinkler irrigation technology by the farmer.
3. Availability of sprinkler irrigable land with water supply.
4. Availability of capital financing to install sprinkling systems.
5. Availability of energy.

These five factors underlie any determination of actual or potential market for sprinkler systems in the area under consideration. And, of course, they are fundamental to any consideration of locating sprinkler irrigation manufacture in Montana. Therefore, the five elements which determine the presence of a market in the region under consideration must first be discussed individually.

1. Technology and Advantages

Sprinkler irrigation has undergone virtual revolution in the past 10 years. Early on, much of the development occurred in Texas, Nebraska, California and Kansas. In the past six years this development has taken giant strides in Washington and Oregon. Essentially the development has been in the direction of eliminating labor costs entailed in the older handline irrigation systems requiring irrigators to move pipes and sprinklers from location

to location. The newer sprinklers are automated, some to a very sophisticated degree including electronic sensors for determining water and fertilizer flows. Of the newer generation sprinklers,the one achieving greatest popularity where sprinkler irrigation has been experienced longer is the pivot or circle sprinkler system. Following is a description of various systems now on the market.

TYPES OF SPRINKLER IRRIGATION SYSTEMS

Skid-tow Line Sprinkler: This system utilizes ridgedly coupled laterals connected by flexible joints to a mainline in the center of the field. The mainline should be partially or totally buried since the laterals must be towed over the mainline when moving the system from one side of the field to the other. Customary length is 1,320 feet but extra length can be added. The Skid-tow Line Sprinkler is best suited for rectangular fields with nearly flat or only slightly rolling terrain. Medium to low intake soils are best used with this system and shallow sandy soils requiring 3 to 5 day irrigation cycles are not recommended. The system requires 45 to 55 pounds of pressure per square inch for operation.

Side Move Sprinkler System: The side move system or side roll systems operate through mounting the entire lateral on wheels and several methods have evolved through the years:

1. Irrigation pipe used as axle for wheels with laterals moved by hand or by small engines.
2. Pipe carried above the wheels and small tow lines added to the laterals.
3. Use of flexible hose or joints of pipe in place of solidly joined pipe to allow continuous movement and automatic self propulsion.

These units are adaptable to several soil types and operate with a pressure of 45 to 55 pounds per square inch.

Boom-type Sprinklers: Boom-type sprinklers have the water distribution apparatus mounted on a moveable carriage. If pipe is used as the water supplier, additional lengths are added as the boom is moved farther and farther from the water source. A single setup can irrigate up to four acres with .80 inches per hour. The newest models utilize high pressure hose as a water supplier and the boom is moved forward continuously by a cable-winch arrangement. Operating pressure of 60 to 70 pounds per square inch is necessary.

Giant Sprinklers: Several variations of the giant sprinkler are currently available. They come in units that are completely hand moved to automated self-moving types some with a capacity as large as 600 gallons of water per minute. Although initial investment price for the giant sprinklers is relatively small they are suited only to high intake sandy soils and can experience problems of compacted soil and distorted distribution due to wind. These systems require 100 or more pounds of pressure per square inch.

Solid Set Sprinklers: Whether these systems are buried or left above ground they are essentially the same as conventional lawn sprinkling or irrigation setups. Some use automated valves for each sprinkler head - others for each lateral line. The greatest asset of this system is the ability to conform to any

type of soil, slope or land shape. They are, however, extremely expensive to install if buried,and must be removed before harvesting if left above ground.

Center Pivot Sprinklers: These sprinklers move around a pivot in the center of the field and are self-propelled by pneumatic, mechanical, hydraulic or electrical means. Increasing nozzle size or frequency of sprinkler head placement insures uniform application of water throughout the length of the line - - anywhere from 1/4 inch to 4 inches per revolution. Length of the line on a quarter section project varies from 1,285 to 1,299 feet and devices are now being marketed that will irrigate corner acreage previously missed by these circular sprinklers. Small 28 acre and 40 acre pivots have proved economical.

Although early pivot models were primarily suited to relatively flat sandy land, recent innovations make the circle sprinklers adaptable to a large variety of terrains and soil types. Sixty-five to eighty pounds of pressure per square inch is necessary for operation though considerably less is needed in systems used in low infiltration soils using smaller four inch pipe. Also less pressure is needed for smaller circles. Center pivot systems also have another advantage. The Federal Land Bank now considers the pivot system an integral part of land value and the system can be added to land values when measuring appraised value for Land Bank loans. Side rolls, tow lines and other less permanent systems

do not qualify.

As important as the sprinkler itself is the water supply system. The costs of a water supply system on large sprinkler irrigated acreage with high lifts and pumping long distances can easily be much greater than the costs of the sprinkling units themselves. Moreover, deep wells with large electrically driven pumps use a good deal of energy and per acre yearly costs can be high. Just drilling high output wells can cost as much as $80 per foot.

Nevertheless, underground water storage is probably 2,000 to 3,000 times greater than all the water in lakes, streams and rivers combined. And, nationwide, about 25% of all irrigation water is groundwater. In Montana, North Dakota, South Dakota and Alberta, given the probable quantities of available groundwater present, this source is virtually untapped for irrigation purposes.

The technology of sprinkler irrigation systems and their components is such that many systems are readily adaptable to the market area being considered here (Montana, North and South Dakota and Alberta) and in Montana, for example, almost 12.5% of all irrigated land was sprinkler irrigated in 1975. Roughly 1/7 of that sprinkler irrigated land has come under sprinklers within the past two years. In the next two years Montana farmers

intend to double the number of acres under sprinkler irrigation over the past two years. And, in the past two years over 47,000 acres have been converted from flood irrigation to sprinkler irrigation in Montana. These data indicate that the adaptability of sprinkler technology to Montana's agricultural conditions is an accomplished fact.

In North Dakota the Garrison Dam project was redesigned specifically for sprinkler irrigation and, therefore, use of sprinkler irrigation technology on that 250,000 acre project is a virtual certainty.

Production and Sprinkler Irrigation

Production advantages to the farmer of sprinkler irrigation vary with types of operation, soils, growing season, terrain, costs of water and energy. The following table shows U.S. dryland and irrigated (not necessarily sprinkler irrigated) crop yields for the western United States.

In most cases except on artificially graded lands well designed sprinkler irrigation systems are more efficient than conventional flood systems. The nature of many soils, often shallow in Montana, and the nature of much of the terrain make artificial land leveling impossible thus increasing the desirability of sprinkler irrigation for new lands being brought under irrigation. Indeed, the efficiency of sprinkler irrigation over conventional flood systems is great enough that many farms (as in the Columbia

Basin irrigation project in Washington state) designed originally for flood irrigation have gone to the more efficient sprinklers in spite of the availability of flood irrigation.

Moreover, in soils where salinity may be a problem, proper sprinkler irrigation can be productively used to "flush" soils to force salinity down away from harmful surface activity.

TABLE NO. 1

IRRIGATION VS DRYLAND

Crop	Ave. Yield U.S.		Index for Western States	
	Ave.	Index	Irrigated Index	Non-Irrigated Index
Alfalfa Hay (tons)	2.82	100	139	73
Corn for Grain (bu.)	85.9	100	128	69
Sorghum (bu.)	53.0	100	149	84
Winter Wheat (bu.)	29.8	100	148	93
Cotton (bales)	.91	100	148	58
Sugar Beets (tons)	17.97	100	107	76

1969 U.S. Agricultural Census Reports

"In computing the indexes, the U.S. average yield per acre for each crop was used as the base figure and set equal to 100. The index of average yields was then computed for the average yield of that portion of the crops that were wholly irrigated and the portion that was not irrigated for each of the two areas. Thus, read across the heading for corn, for example. Average U.S. yield was 85.9 bu. per acre. The irrigated index was 128, or 128% more than 85.9. Average irrigated yield: 110 bushels per acre. Dryland index is 69, or 69% of 85.9. Average dryland yield: 59 bushels per acre."

Source: Irrigation Age, October, 1975.

A REGIONAL VIEW - ACCEPTABILITY OF SPRINKLER IRRIGATION

In the region under consideration (Montana, North Dakota, South Dakota, and Alberta) the growth in the use of sprinkler irrigation has not been as rapid as it has been in Nebraska, Kansas, California, Idaho, Oregon or Washington. In the course of research for this study factory representatives from some of the major sprinkler firms in the industry and sales representatives both in state and out have repeatedly pointed out that the areas under study are from five to ten years behind other areas in accepting sprinkler irrigation.

However, recent indicators of installations of sprinkler irrigation in Montana, for example, show that rapid growth rates in certain areas of the state are now underway. Statewide there has been a 16% increase in the number of newly sprinkler irrigated acres over the past two years (from 241,344 acres to 281,433 acres) or, an increase of 40,089 acres. These 40,089 acres represent only new lands under irrigation. In addition to new lands approximately 47,254 acres have been converted from flood irrigation to sprinkler irrigation in the past two years. (It is notable that only 455 acres have been converted from sprinkler back to flood irrigation during the same period.) These two figures represent newly installed sprinkler irrigation systems covering 87,343 acres over the past two years in Montana. (See Table No. 2.)

TABLE NO. 2

PRESENT IRRIGATED LANDS
"CONVERTED SYSTEMS" FOR 1974-75[1]

COUNTY	ACRES		
	Flood to Sprinkler	Sprinkler to Flood	Loss of Irrigated Land
Beaverhead	7,000		300
Big Horn			1,200
Blaine	400		200
Broadwater	4,673		
Carbon	1,100	100	800
Carter		30	
Cascade	3,207		
Chouteau	1,292		50
Custer			
Daniels			
Dawson	80		
Deer Lodge	575		2,020
Fallon			180
Fergus			
Flathead	500		4
Gallatin	2,342		880
Garfield	100		
Glacier			
Golden Valley			
Granite	895		300
Hill	470		
Jefferson	2,400		500
Judith Basin	300		
Lake			
Lewis & Clark	1,926		1,500
Liberty			
Lincoln	600		20
Madison	5,520		850

1. Based on data submitted by 53 of 56 counties reporting to Dept. of Natural Resources, through the Soil Conservation Services

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PRESENT IRRIGATED LANDS
"CONVERTED SYSTEMS" FOR 1974-75

COUNTY	ACRES		
	Flood to Sprinkler	Sprinkler to Flood	Loss of Irrigated Land
McCone			
Meagher	497		50
Mineral			
Missoula			
Musselshell			
Park	1,560		
Petroleum	200		
Phillips	80		80
Pondera	3,300		808
Powder River			
Powell	1,683		1,030
Prairie			50
Ravalli	240		
Richland			345
Roosevelt			
Rosebud	145		50
Sanders	1,870		
Sheridan			
Silver Bow	200		5,000
Stillwater		325	50
Sweet Grass	600		900
Teton	3,399		
Toole			
Treasure			
Valley	80		
Wheatland			
Wibaux			
Yellowstone	20		64,000
TOTAL	47,254	455	81,167

It is perhaps to be expected that those localities which have been active in installing new sprinkler systems in the past two years are, with few exceptions, the same localities planning increased sprinkler irrigation acreage over the next two years. Planned acreage to come under sprinkler irrigation through 1977 is 96,047 acres or 2½ times the expansion seen statewide in the past two years.

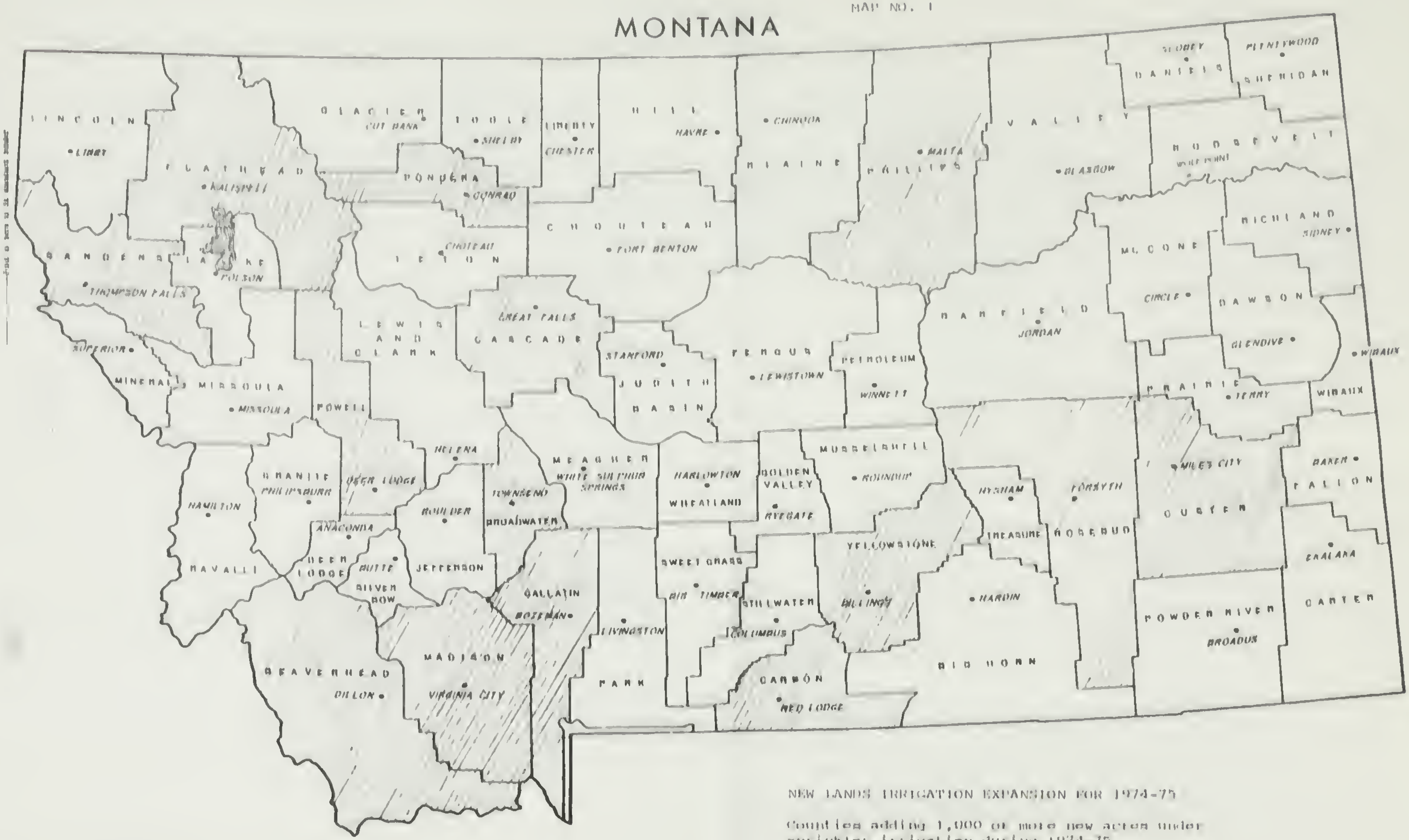
Past expansion and planned expansion is taking place in more or less specific locations in Montana's river basin drainages.

In the north central counties of Cascade, Teton, Glacier, Pondera, Chouteau and Hill there has been considerable activity in the past two years and additional expansion of approximately 14,000 acres is planned for 1977. According to approximate figures from the Federal Land Bank in Great Falls loans for sprinkler irrigation increased over 2½ times from 1970 to 1973 - - from $40,000 to $128,000. From 1973 to 1974 loans for sprinkler installation increased from $128,000 to $438,000 or a threefold increase. From 1974 to September of 1975 loans to area farmers for sprinkler irrigation facilities increased by five times - - from $438,000 to $2,240,000. And, according to a Federal Land Bank official, applications for loans for gravity irrigation have decreased.[1]

1. Information from communication with Jerry Daily, Federal Land Bank of Great Falls.

MAP NO. 1

MONTANA

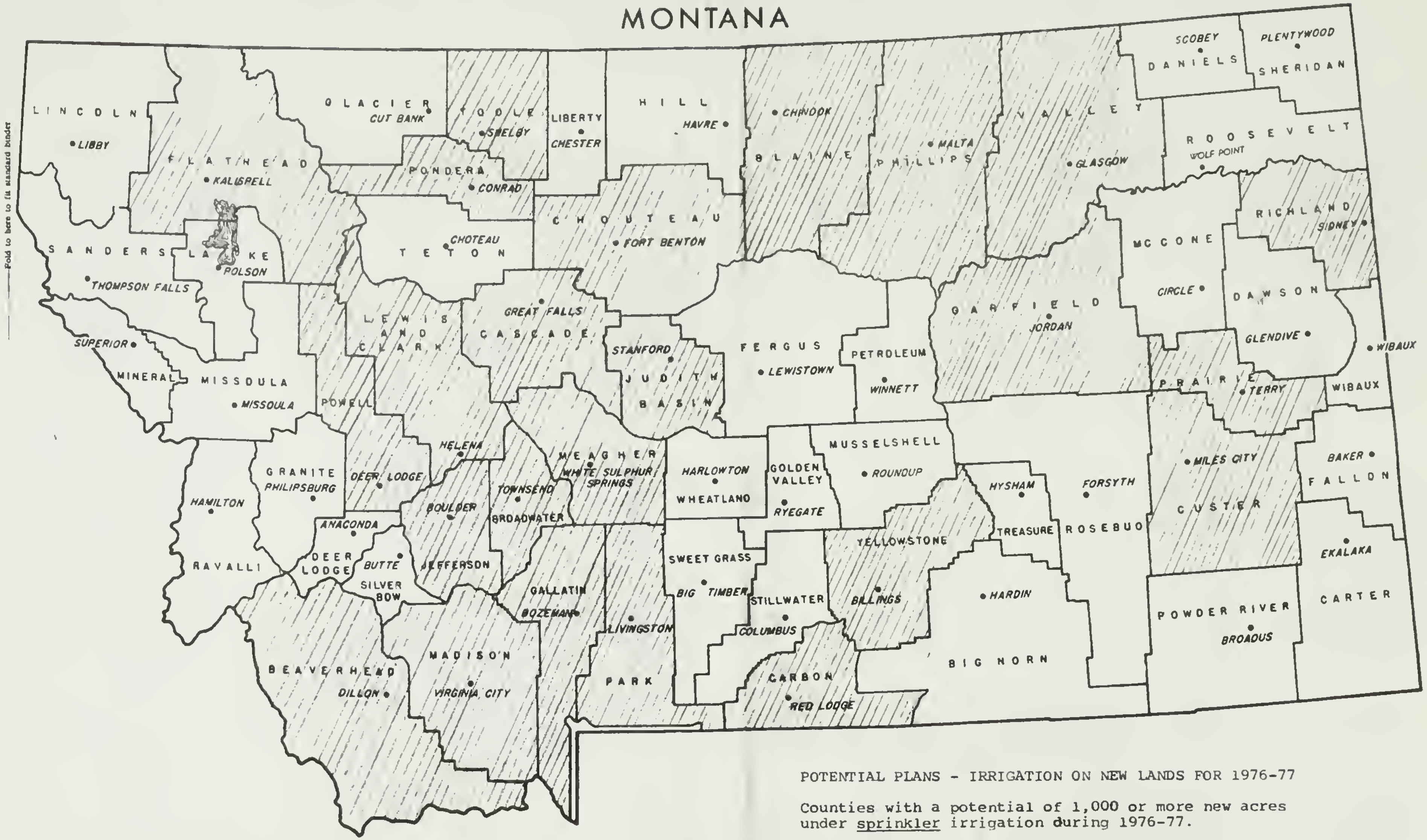


NEW LANDS IRRIGATION EXPANSION FOR 1974-75

Counties adding 1,000 or more new acres under sprinkler irrigation during 1974-75.

MAP NO. 2

MONTANA



POTENTIAL PLANS - IRRIGATION ON NEW LANDS FOR 1976-77

Counties with a potential of 1,000 or more new acres under sprinkler irrigation during 1976-77.

In the Milk River drainage of the Missouri River in the counties of Blaine, Phillips and Valley more than 40,000 acres are planned for sprinkler irrigation over the next two years.

In the Yellowstone drainage the counties of Park, Yellowstone, Carbon, Treasure, Rosebud and Custer approximately 10,000 acres have gone under sprinkler irrigation in the past two years.

On the upper Missouri headwaters in Beaverhead, Madison and Gallatin there are currently almost 60,000 acres under sprinkler irrigation. In the next two years 6,300 sprinkler irrigated acres are expected to be added. During the past two years 4,732 acres went under sprinklers.

These examples illustrate that while Montana has been slow in developing irrigation sprinkling relative to other agricultural areas in the nation, an increase in farmer acceptance of sprinkler irrigation technology is gaining significant momentum in several areas of the state. (See Table No. 3.)

TABLE NO. 3

NEW & POTENTIAL IRRIGATION EXPANSION [1]

COUNTY	NEW LANDS IRRIGATION EXPANSION FOR 74-75			POTENTIAL PLANS IRRIGATION ON NEW LANDS FOR 76-77		
	SPRINKLER Pivot	SPRINKLER Other	GRAVITY	SPRINKLER Pivot	SPRINKLER Other	GRAVITY
Beaverhead		1,200	200	600	600	200
Big Horn	180	40		140	321	
Blaine	900		350	1,650	80	700
Broadwater	825	1,973		130	1,415	
Carbon	1,820	735	200	320	1,500	400
Carter			609			700
Cascade	1,066	500	100	1,500	3,500	200
Chouteau	411	1,045	170	556	1,160	510
Custer	1,800	120	300	1,000		500
Daniels			80	550		26
Dawson	360	40	20	560		400
Deer Lodge	110	100		60	100	
Fallon					40	
Fergus	180	130	150	250	200	200
Flathead		2,000			2,000	
Gallatin	800	1,542		1,200	2,400	4
Garfield	100			600	400	150
Glacier				400	400	
Golden Valley	480	360			315	
Granite		340	50		500	50
Hill		210	15	400	300	500
Jefferson		750			1,500	500
Judith Basin	140	580	1,210	560	500	500
Lake		80			80	
Lewis & Clark	100	350		900	3,800	500
Liberty	100	60	220		100	120
Lincoln		200	100		400	200
Madison	30	1,160			1,500	250

1. Based on data submitted by 53 of 56 counties reporting to Dept. of Natural Resources, through the Soil Conservation Services.

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TABLE NO. 3 (continued)

NEW & POTENTIAL IRRIGATION EXPANSION

COUNTY	NEW LANDS IRRIGATION EXPANSION FOR 74-75			POTENTIAL PLANS IRRIGATION ON NEW LANDS FOR 76-77		
	SPRINKLER		GRAVITY	SPRINKLER		GRAVITY
	Pivot	Other		Pivot	Other	
McCone	160	50	200	700	200	1,000
Meagher	200	310	200	254	900	100
Mineral						
Missoula						
Musselshell		288	150		400	200
Park	790		50	1,110		
Petroleum		100				100
Phillips	1,040	80		1,000		100
Pondera	680	600		1,000	4,000	
Powder River			800	600		800
Powell	109	2,640	50		1,100	
Prairie			150	1,270	500	100
Ravalli		360				
Richland		360	4,003	518	1,013	644
Roosevelt	420					100
Rosebud	2,835		600	300		700
Sanders		2,205	30		720	
Sheridan	80					
Silver Bow		200			100	
Stillwater		100		130	200	700
Sweet Grass		150	200		250	150
Teton		510		820	160	
Toole		240	60	500	500	150
Treasure	365		250	215		100
Valley	500	200	200	20,000	20,000	10,000
Wheatland			363			
Wibaux						
Yellowstone	1,300	200	250	2,600	500	2,000
TOTAL	17,881	22,093	11,330	42,393	53,654	23,554

TABLE NO. 4

IRRIGATED LANDS AS OF 9/15/75 [1]

COUNTY	IRRIGATED ACRES		
	SPRINKLER Pivot	SPRINKLER Other	GRAVITY
Beaverhead	300	24,000	320,000
Big Horn	1,080	40	63,000
Blaine	2,000	850	69,500
Broadwater	956	11,865	20,406
Carbon	3,730	2,270	95,000
Carter		120	66,255
Cascade		1,073	30,640
Chouteau	691	4,135	7,512
Custer	3,280	150	22,746
Daniels		65	1,803
Dawson	860		12,524
Deer Lodge	940	1,177	21,065
Fallon			100
Fergus	600	500	13,680
Flathead	150	25,000	4,000
Gallatin	2,100	18,902	49,696
Garfield	350		5,150
Glacier		250	18,500
Golden Valley	960	445	4,738
Granite		4,300	31,700
Hill	480	575	8,863
Jefferson		500	14,030
Judith Basin		760	10,675
Lake		50,000	58,000
Lewis & Clark	480	5,200	18,195
Liberty	380	440	2,250
Lincoln		4,300	4,200
Madison	973	10,164	61,138

1. Based on data submitted by 53 of 56 counties reporting to Dept. of Natural Resources, through the Soil Conservation Services.

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TABLE NO. 4 (continued)

IRRIGATED LANDS AS OF 9/15/75

COUNTY	IRRIGATED ACRES		
	SPRINKLER		GRAVITY
	Pivot	Other	
McCone	160	200	5,000
Meagher	1,116	1,607	30,477
Mineral			
Missoula			
Musselshell		922	10,112
Park	2,630	1,470	43,673
Petroleum	280	75	7,978
Phillips	1,400	80	87,140
Pondera	1,680	4,000	95,000
Powder River			24,205
Powell	190	7,910	62,809
Prairie	930	210	11,000
Ravalli		40,195	70,907
Richland		360	46,301
Roosevelt	420		12,500
Rosebud	4,050		31,950
Sanders	130	10,088	13,973
Sheridan	100		
Silver Bow		300	5,150
Stillwater	260	2,000	29,000
Sweet Grass		700	51,000
Teton	780	3,329	125,891
Toole		360	1,470
Treasure	540		17,602
Valley	500	500	38,500
Wheatland			15,470
Wibaux			
Yellowstone	2,600	400	98,000
TOTAL	38,076	241,787	1,970,474

AVAILABILITY OF ENERGY

At the current rate of sprinkler irrigation development in Montana it would appear that adequate energy is available for the time being. Increasing the load capability of rural electrical lines will be a short run necessity. As the costs of fossil fuels increase there will be greater demand for electrical energy. Mr. Gordon Sloggett of Oklahoma State University has produced figures describing energy demand for Montana irrigation needs. Table No. 5 presents his data and projections.

TABLE NO. 5

ACRES IRRIGATED BY ENERGY FACILITY[1]

1974 Base Data	Electricity	Other Energy Gas, Diesel, Etc.	Total
Present	270,510	53,520	324,030
Minimum projected 20 yrs.	405,765		453,642
Maximum projected 20 yrs.	608,647		635,000

Kilowatt hours of electricity needed for on farm pumping units by 1995 are estimated by Sloggett to range from a minimum of 335,435 KWH to a maximum of 630,618 KWH.[2]

Based on Consultants Collaborative's data Sloggett's data on acreages likely to be irrigated by energy facilities are on the low side by at least 200,000 acres by 1995.

In Montana's case with the construction of Colstrip Plants

1. Energy Used For Pumping Irrigation Water, Montana, 1974, Preliminary Draft for Discussion Purposes Only, Gordon Sloggett, U.S.D.A., E.R.S., Oklahoma State University.
2. Ibid.

One and Two there is little danger of an electrical shortage for irrigation facilities in the short run. A shortage of natural gas in Montana virtually excludes new pumping facilities from reliance on that energy source.

As the development of new sprinkler irrigation systems accelerates in Montana, North Dakota, Alberta and Saskatchewan, the availability of energy will have to be continually monitored. As it now stands the study area is not short of energy to any critical degree. Moreover, the petroleum fields of the Canadian provinces and the coal fields of North Dakota and Montana are potentially abundant energy resource reserves. Whether or not the social, economic and political costs of developing these reserves can be met is a question only time can resolve. One point is certain, there is no other place in North America where potential energy from water and fossil fuel resources is so closely linked to large areas of potential sprinkler irrigable land.

TABLE NO. 6

NUMBER OF PUMPING STATIONS & SOURCE OF POWER, 1975 [1]

COUNTY	IRRIGATION WELLS	SOURCE OF POWER				
	Acres	Gas	Electric	Diesel	Liquid Petrol.	Horse Power
Beaverhead	200	2	200	4		12,000
Big Horn	140	1	26	2		3,145
Blaine	300					
Broadwater	2,534		111			7,189
Carbon	1,000		50	15	2	1,775
Carter		5	1	7		240
Cascade	32		42			3,175
Chouteau	4,666	10	41	11		2,533
Custer			30	25		
Daniels			1	7	8	
Dawson			3	11	2	1,250
Deer Lodge	243		24			933
Fallon						
Fergus	40		8	3		780
Flathead	12,000	2	300	5		11,230
Gallatin	25	8	79	30	15	6,600
Garfield			1	3	7	
Glacier						
Golden Valley		3	47			1,560
Granite	60	10	60			2,500
Hill		3	33	1	3	1,400
Jefferson	350	6	50			900?
Judith Basin			5	10		
Lake	300		170	60		
Lewis & Clark	2,750	5	55	15	5	
Liberty		1	12	15	1	1,500
Lincoln		1	80	2		2,340
Madison	400	8	78	2		5,970

1. Based on data submitted by 53 of 56 counties reporting to Dept. of Natural Resources, through the Soil Conservation Services.

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TABLE NO. 6 (continued)

NUMBER OF PUMPING STATIONS &
SOURCE OF POWER, 1975

COUNTY	IRRIGATION WELLS		SOURCE OF POWER			
	Acres	Gas	Electric	Diesel	Liquid Petrol.	Horse Power
McCone		25	35	10	2	
Meagher	150	2	8	8	1	1,490
Mineral						
Missoula						
Musselshell		6	45			2,300
Park	30		67	10		
Petroleum	100	5	15			500
Phillips			62			
Pondera		2	36	3		2,195
Powder River	600		7	40		25 - 60
Powell	140	9	62	5		3,242
Prairie	250	1	5	1		755+
Ravalli	11,800		804			9,130
Richland	300		7	15	2	
Roosevelt	10	2	1	1	2	450
Rosebud	20	10	53	22		
Sanders	35		135	7		
Sheridan		1	1			
Silver Bow	200	1	8			250
Stillwater	55		6			800
Sweetgrass		5	7	3	1	
Teton	245		31	4		1,550
Toole		6	8	15		1,500
Treasure	80	4	39			
Valley	500	15	80	20		
Wheatland			2			
Wibaux						
Yellowstone			10	3		
TOTAL	39,255	159	3,061	385	51	111,242

AVAILABILITY OF SPRINKLER IRRIGABLE LAND WITH WATER SUPPLY

Sprinkler irrigable land is a composite of two major factors - - proper soil conditions and the economic availability of water in sufficient quantities. While the more advanced sprinkler technology uses less water more efficiently and increases the possible variety of irrigable soils and terrain over conventional gravity systems, severe limitations exist. These limitations concern the economic application of water to soils having characteristics compatible with irrigation. It is important to emphasize these constraints because very often figures are cited indicating water availability or soils availability without consideration of the economic proximity of the two factors. In Montana, for example, a soils inventory reaveals that there are approximately 11,000,000 potentially irrigable acres in the state. This figure, however, is only a description of soils characteristics and is unrelated to the costs of applying irrigation water to these soils. In some cases irrigable soils are great distances from water supplies, underground water sources near these soils are unknown, or, environmental considerations of water storage and transfer are unknown, and, impoundment and transportation costs are not economically or politically feasible.

In most cases in the area under consideration few systematic studies of existing soils and their potential economic adaptability

to sprinkler irrigation have been undertaken. Two localities in the study area have, however, received thorough study and they provide a core of information on the potential market for irrigation sprinkler systems. These two areas are the Yellowstone Valley in Montana and the Garrison Dam project in North Dakota.

Yellowstone River Basin: The Water Resources Division of the Montana Department of Natural Resources is currently conducting a study to estimate the future water demand for the Yellowstone River Basin. These studies are preliminary in nature and consider three levels of development.

(1) Irrigable land that is adjacent to the water supply. These areas can be served by expanding present facilities, or constructing a pipeline which is less than one mile in length.

(2) Areas which can be served by the construction of a pipeline one to five miles in length. Alternatives within this developmental level are further broken down by vertical lift requirements.

(3) Areas served by a pipeline that is greater than 5 miles long. Also included in this level are areas which require siphons or re-lift pumps.

The results of these preliminary estimates reveal the following irrigation potentials.

TABLE NO. 7

IRRIGATION POTENTIAL BY COUNTY [1]

COUNTY	POTENTIAL IRRIGATION (ACRES)
Upper Yellowstone	
*Park	29,284
*Sweetgrass	27,370
*Carbon	24,830
Stillwater	15,998
Total	97,482
Middle & Lower Yellowstone	
Yellowstone	102,320
Big Horn	138,147
Treasure	52,527
Rosebud	70,290
Powder River	96,887
Custer	59,690
Prairie	43,745
Dawson	71,848
Wibaux	368
Richland	63,719
Total	699,541
BASIN TOTAL	797,023

* Work not completed; estimate only.
Note: These data are taken from a preliminary draft.

1. Dept. of Natural Resources, Water Resources Division.

TABLE NO. 8

IRRIGATION POTENTIAL BY RIVER BASIN [1]

RIVER BASIN	POTENTIAL IRRIGATION (ACRES)
Yellowstone	428,196
Stillwater	2,155
Rosebud	5,715
Clarks Fork	20,789
Pryor Creek	32,014
Big Horn	99,779
Little Big Horn	39,875
Tongue	23,616
Powder	138,803
Armells Creek	6,081
TOTAL	797,023

Note: These data are taken from a preliminary draft.

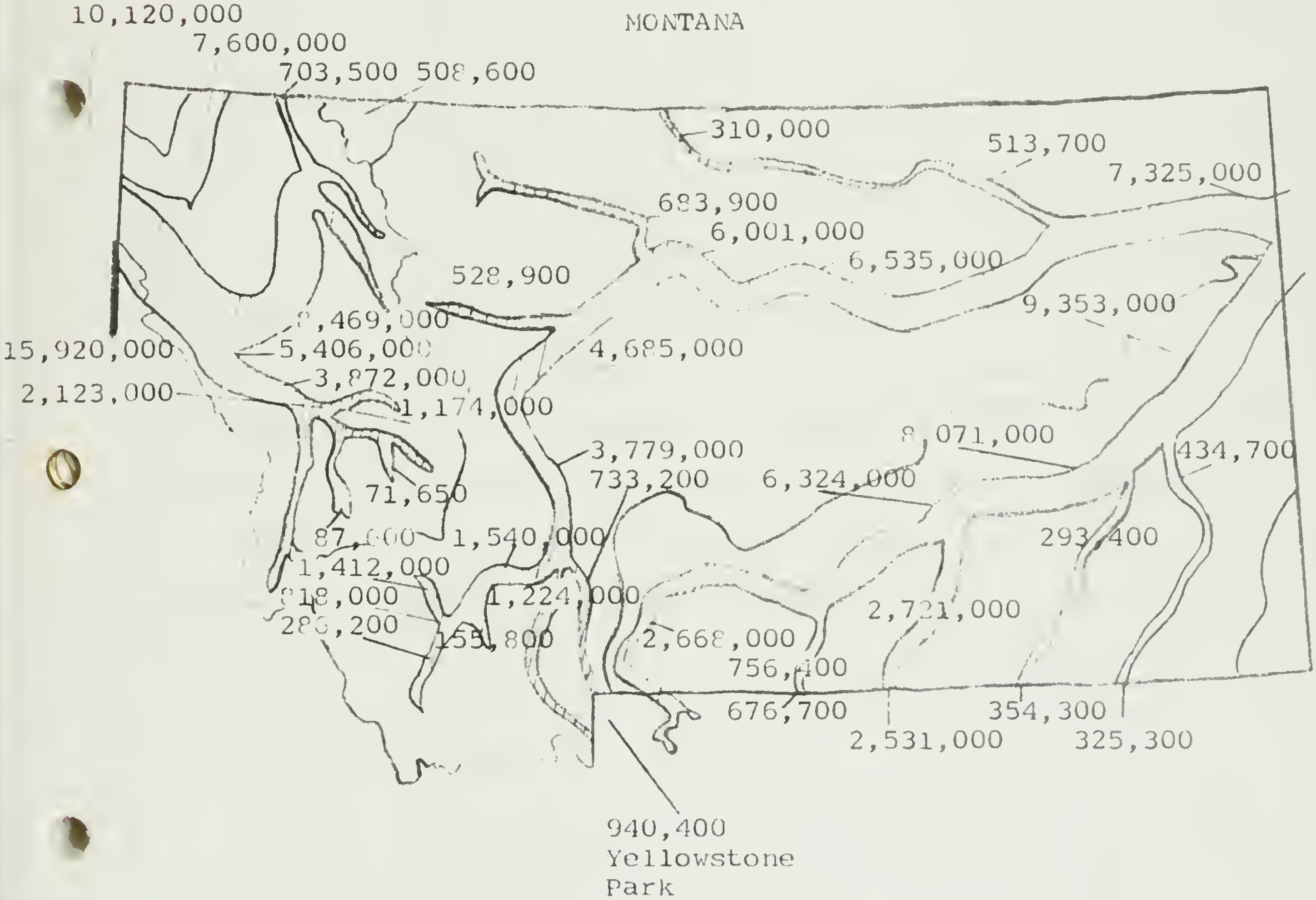
The Missouri River Drainage: Hard data of the type developed for the Yellowstone Basin by the Department of National Resources, Water Resources Division is unavailable for the Missouri River Basin. Studies combining the quantities of irrigable soils with economically potential water supplies await additional funding. However, some data can be adduced. U.S. Bureau of Reclamation inventories conducted along the Missouri east of Fort Peck since 1952 indicate that the Glasgow bench area has approximately 10,000 irrigable acres for which water is available. On the south side of the river in Valley County the south bench area has approximately

1. Dept. of Natural Resources, Water Resources Division.

MAP NO. 3

MONTANA MEAN ANNUAL STREAM FLOW

Figures: Average annual discharge in acre feet



Source: INVENTORY SERIES REPORT No. 6, Revised, October 1972, Montana Department of Natural Resources and Conservation, Water Resources Division.

26,000 acres within economic distance of water. On the north or reservation side of the river below Fort Peck another 3,000 acres is irrigable. And, in Garfield County 1976-77 plans indicate 1,000 or more acres going under sprinkler irrigation.

Upstream from Fort Peck the quality of soils and their relation to pumping lifts and water transport problems are difficult to assess. In the Fairfield area it is estimated that at least 80,000 acres are economically irrigable in the Fairfield bench area. Moreover, in Pondera County the Pondera Canal could potentially serve between 40,000 and 80,000 acres of irrigable soil. It is also notable that on the Marias River drainage in Toole County and along the Missouri drainage in Chouteau County, 1976-77 plans indicate 1,000 or more acres coming under sprinkler irrigation.

These data indicate that land possessing irrigable soils and economically feasible sprinkler irrigation water on the Missouri below the Great Falls of the Missouri can be conservatively estimated at 202,000 acres. And, plans for 1976-77 in Blaine and Phillips Counties along the Milk River account for another 2,600 acres. This means that a rough estimate of economically feasible irrigated acreage in the Missouri drainage below the Great Falls of the Missouri would be approximately 204,000 acres. From Soil Conservation District estimates there were approximately 10,000 sprinkler irrigated acres in that lower drainage as of September, 1975.

TABLE NO. 9

ESTIMATED & EXISTING SPRINKLER ACREAGE ON LOWER MISSOURI [1]

Estimated potential sprinkler irrigable acreage on lower Missouri	204,000 acres
Existing sprinkler irrigated acreage on lower Missouri as of 1975	10,000 acres

On the upper Missouri above the Great Falls of the Missouri considerable sprinkler irrigation activity is underway. All of the counties lying in the upper Missouri drainage plan for 1,000 or more acres to come under sprinkler irrigation before 1977. The total sprinkler irrigated acreage in the upper Missouri drainage planned between 1976-77 is 15,199 acres.

Due to an absence of detailed and systematic studies of the entire soil, water and water transport system for the Missouri Basin the estimates contained here are rough estimates only. They are conservative however, and they indicate that between 200,000 and 250,000 acres could be sprinkler irrigated on this river system.

Montana's Columbia Basin Drainage: West of the Continental Divide the Kootenai, Clark Fork, Flathead and Bitterroot drainages constitute Montana's Columbia Basin drainage system. Between 1974 and 1975, 13,574 acres in this basin were put under sprinkler irrigation. Estimates for 1976-77 are that nearly

1. Soil Conservation District Data.

4,000 more acres are planned for this drainage. This estimate is unquestionably low in view of the lack of estimates for Missoula, Mineral and Sanders counties by Soil Conservation Districts in those counties. The agricultural topography of this drainage system, consisting of small mountain valleys, precludes large acreages from irrigation of any type. Nevertheless, land ownership patterns and topography do indicate that smaller sprinkler irrigation systems may be adaptable to the area.

Underground Water Systems in Montana: Map No. 4 shows the locations of water bearing unconsolidated rocks and potential well yields. Deep wells and wells of large diameter are not yet a major factor in Montana, North Dakota and Alberta. In Montana, however, the presence of vast areas of high yield wells could mean substantially increased irrigation from well sources. And, as the Soil Conservation Service points out in its Headwaters RC&D Project Plan - Montana:

> "Costs of pumping these wells to provide a full supply of water for gravity flow irrigation systems is excessive. Therefore, sprinkler systems are continually being installed to improve water management." (p. 41)

Largely untapped, underground water sources in Montana will increasingly be a factor in increased use of sprinkler irrigation. If the experience in Washington's Columbia Basin is any indicator, the vast river system in Montana with potentially high yield wells throughout the system should make substantial acreage available

MAP NO. 4

Map showing real distribution of water-bearing unconsolidated rocks and potential well yields.

MONTANA

Area where wells yielding 1,000 gpm or more are generally possible.

Area where wells yielding from 250 to 1,000 gpm are generally possible.

Source: U.S. Geological Survey

for sprinkler irrigation in bottom lands and benches where water lifts above ground are under 100 to 200 vertical feet.

SUMMARY OF MONTANA'S SPRINKLER IRRIGATION POTENTIAL

Table No. 10 represents the potential acreage for irrigation application in Montana's major river drainage systems. Necessarily it is based on: the initial projections of the Montana Water Resources Division in the case of the Yellowstone Basin; a U.S. Bureau of Reclamation estimate on the lower Missouri; and on Soil Conservation District figures for planned sprinkler irrigation during 1976 and 1977 for portions of the lower Missouri, the upper Missouri and Montana's Columbia Basin drainage system. These data probably under represent the potential sprinkler irrigation acreage in Montana for the following reasons: First, in those areas where sprinklers have been introduced there is a higher rate of planned use over the next two years. This means that as the advantages of sprinklers become known in a given area there is more rapid acceptance of them. In areas where other forms of irrigation are in use but sprinklers are not yet common there are fewer acres projected for sprinkler irrigation. Second, in the western part of Montana some Soil Conservation Districts have not reported existing and planned use of sprinkler irrigation. Third, the use of wells is increasing but the rates at which wells will be converted from gravity to sprinkler irrigation due to increasing energy costs is not known. Fourth, given the vast potential for high yield wells in Montana the increased acreages

available along the Missouri and Montana Columbia Basin drainages is difficult to estimate without a detailed analysis beyond the scope of this study.

TABLE NO. 10

POTENTIAL IRRIGATED ACRES IN MONTANA BY DRAINAGE [1]

DRAINAGE	POTENTIAL IRRIGATED ACRES IN MONTANA
Yellowstone	797,023
Lower Missouri	204,000
Upper Missouri	15,000 (sprinklers only)
Montana Columbia Basin	4,000 (sprinklers only)
TOTAL	1,020,023

The acreage for the Yellowstone and lower Missouri drainages in Table No. 10 are total potential irrigable acres. Statewide plans for newly irrigated lands indicate that 87% of all newly irrigated lands will come under sprinklers. Using this percentage as a projection for the potential acreage in the Yellowstone and lower Missouri drainages Table No. 11 shows the potential sprinkler irrigated acreage for Montana.

TABLE NO. 11

POTENTIAL SPRINKLER IRRIGATED ACREAGE IN MONTANA BY DRAINAGE [2]

DRAINAGE	SPRINKLER IRRIGATED ACRES
Yellowstone & lower Missouri	870,890
Upper Missouri	15,000
Montana Columbia Basin	4,000
TOTAL	889,890

1., 2. Soil Conservation District and Water Resources Division estimates.

POTENTIAL SPRINKLER SYSTEM SALES IN MONTANA BASED ON 889,890 POTENTIAL SPRINKLER IRRIGATED ACRES

Assuming that a complete sprinkler system was installed on each quarter section represented by the 889,890 potential sprinkler irrigated acres derived in this study, Table No. 12 illustrates potential sales of quarter section systems in Montana.

TABLE NO. 12

POTENTIAL SPRINKLER SYSTEM SALES

Potential Sprinkler Irrigated Acres	Number Quarter Section Systems
889,890	5,561.1

The figures in Table No. 12 indicate the approximate number of quarter section pivot type or other systems that would be required to irrigate Montana's potential sprinkler irrigable acreage. (However, since the typical pivot type system irrigates only 130 acres instead of the full 160 acres of a quarter section, theoretically more circle type systems would be required.)

While data do not exist as to all preferences in Montana for individual types of sprinkler systems some projection of preference is possible. Soil Conservation Service data indicate that sprinkler irrigation of new lands during 1976 and 1977 will use the following systems.

TABLE NO. 13

TYPES OF SPRINKLER SYSTEMS TO BE USED IN 1976-77 EXPANSION

TYPE OF SYSTEM	ACRES	PERCENT
Pivot Sprinkler	42,393	43.6%
Other Sprinkler	53,654	56.4%
TOTAL	97,047	100.0%

Again assuming that complete quarter section sprinkler systems were used for Montana's potential sprinkler irrigable acreage and all acreage was sprinkled on the basis of the types of systems planned for 1976-77, Table No. 14 shows the number of pivots and other sprinkler systems required for 889,890 acres.

TABLE NO. 14

NUMBER OF SPRINKLER SYSTEMS FOR MONTANA'S POTENTIAL ACREAGE

TYPE OF SPRINKLING SYSTEM	# OF SYSTEMS REQUIRED FOR 889,890 ACRES	PERCENT OF SYSTEMS
Pivot Sprinklers	2,391.3	43.6%
Other Sprinklers	3,169.8	56.4%
TOTAL	5,561.1	100.0%

It is important to again stress that the figure of 889,890 acres of potential sprinkler irrigated land is probably a conservative estimate for Montana. New lands coming under sprinkler irrigation in 1974-75 amounted to 40,089 acres. During 1976-77 Soil Conservation Service data indicate that figure is

likely to more than double to 97,047 newly irrigated acres in a two year period. At that rate of increase the 889,890 acre figure would be reached in less than nine years.

In adopting these irrigable acreage figures two important factors should be kept in mind. The figures developed by the Water Resources Division of Natural Resources for the Yellowstone Basin include some fairly extensive canal and pumping installations not now in existence. The figures for the lower and upper Missouri do not anticipate such extensive development and are therefore considerably lower. If, however, the criteria used in the mapping and engineering work undertaken for the Yellowstone Basin were applied to the upper and lower Missouri Basins there would be a significant increase in the projected potential irrigable acreage there. It is not out of the question to assume that potential for sprinkler systems on the Missouri drainage is as great as it is for the Yellowstone Basin. This is particularily true if the potential for deep wells along the Missouri drainage is considered. In Valley County, for example, plans to sprinkler irrigate nearly 20,000 acres over the next two years depend almost entirely on deep wells primarily located in water bearing consolidated rock lying in the Milk River aquafer. This development alone, if all 20,000 acres were placed under center pivots, would require at least 150 quarter section pivot systems.

Unfortunately, hard data for the Missouri drainage is unobtainable until a detailed study is made and Consultants Collaborative has used the more conservative figure. In the Columbia Basin drainage of Montana the potential for sprinkler irrigation is again very likely underestimated. The topography and land ownership patterns of this western portion of the state probably dictate smaller sprinkler system installations. Since a main concern of this study is a center pivot manufacturing plant, it should be emphasized that the smaller pivot systems of 40 acres now coming on the market will be readily adaptable to this area. And, of course, wells for sprinkler irrigation in this western area will be a very important factor in sprinkler irrigation.

Based on these considerations, for which hard data is not available, it would be difficult to argue against an estimate that sprinkler irrigation potential in Montana is double that presented in the estimates here. This doubling of the estimated acreage would mean, for example, that potential center pivot sales could be as high as 4,800 quarter section units.

ADJACENT MARKETS FOR A MONTANA MANUFACTURED SPRINKLER SYSTEM

A major factor in the market for a sprinkler irrigation system manufacturer in Montana is the potential market for systems in adjoining states. Interviews with salesmen, distributors, manufacturer representatives and manufacturers indicate that the South Dakota market would be extremely difficult for a newly established Montana firm to penetrate. South Dakota's proximity to Nebraska and Kansas where several large manufacturers of sprinkler systems are located has resulted in extensive and intensive market coverage. Moreover, transportation costs from possible Montana manufacturing points to South Dakota's major irrigable acreage are not an advantage over Nebraska based firms. Geographical and market coverage considerations preclude South Dakota as a viable market for a sprinkler system of Montana manufacture.

North Dakota, on the other hand, is within the market area of a sprinkler system manufacturer located in Montana. Moreover, the planned Garrison Diversion Unit irrigation project represents a substantial potential market for sprinkler irrigation systems. Table No. 15 gives the proposed construction schedule for the various sections of this project.

It should be noted that almost the entire Garrison project has been designed for sprinkler irrigation application. Moreover, a sprinkler system designed for the climatic and soils conditions

TABLE NO. 15

PROPOSED CONSTRUCTION SCHEDULE

GARRISON DIVERSION UNIT

FACILITY	ESTIMATED QUANTITY	YEAR TO BE COMPLETED*
SOURIS SECTION		
Karlsruhe Irrigation Facilities	12,200 acres	1988
Middle Souris Irrigation Facilities	103,800 acres	1988
OAKES SECTION (North Dakota)		
West Side Irrigation Facilities	19,770 acres	1980
East Side Irrigation Facilities	26,210 acres	1984
LaMOURE SECTION		
Irrigation Facilities	13,350 acres	1982
CENTRAL NORTH DAKOTA SECTION		
Warwick-McVille Irrigation Facilities	47,220 acres	1984
New Rockford Irrigation Facilities	20,935 acres	1985
Lincoln Valley Irrigation Facilities	6,515 acres	1980
TOTAL ACRES	250,000 acres	

Source: Draft Environmental Statement, Initial Stage, Garrison Diversion Unit, Pick-Sloan Missouri Basin Program, North Dakota, Prepared by: Regional Office, Upper Missouri Region, Billings, Montana, Bureau of Reclamation, Department of the Interior

* These completion dates are the latest 1976 estimates by the Upper Missouri Region office and are, of course, contingent upon appropriations from Congress.

of the Missouri and Yellowstone drainages of Montana would have direct application to the climate and soils conditions encountered in the Garrison Diversion Unit project.

As designed the Garrison project covers a large crescent from roughly Minot in the northwest to the southeastern corner of North Dakota. (See Map No. 5.)

In addition to the North Dakota markets the province of Alberta is a potential market for a sprinkler irrigation system manufactured in Montana. Officials from Alberta have studied sprinkler irrigation in Washington's Columbia Basin during the past year and representatives of private Alberta firms have been involved with U.S. firms in design and manufacturing discussions. At least one Alberta firm has joined with an American based firm to manufacture center pivot sprinkler systems in Calgary, Alberta. Detailed information on the extent of sprinkler irrigation in Alberta is not available. Estimates of irrigable acreage are available however.

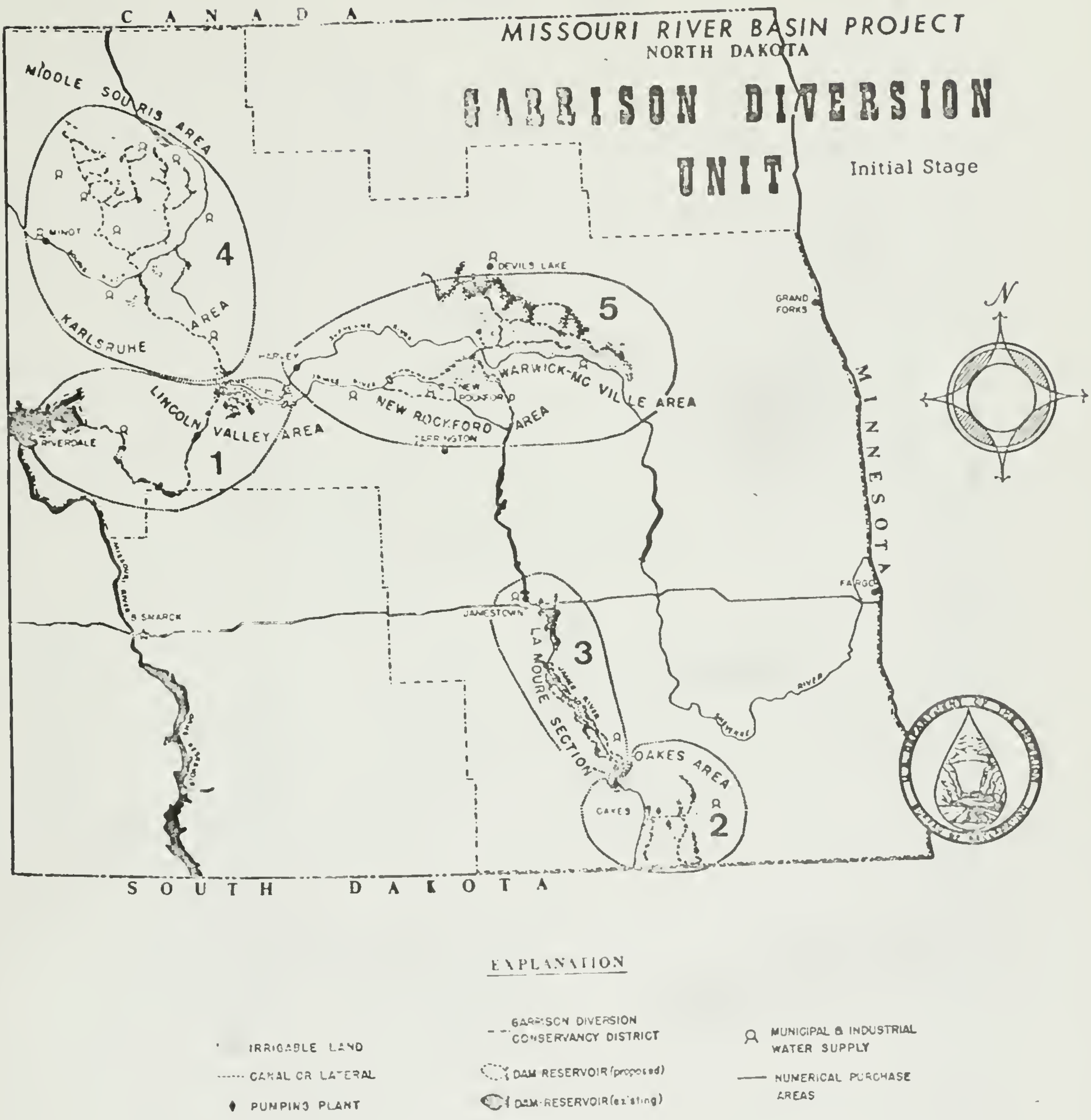
At the present time there are an estimated one million acres under irrigation in Alberta. Thus far extensive use of underground wells has not been undertaken in the province. A low estimate of available irrigable acreage in Alberta is 150,000 acres using surface water. The estimated maximum potential irrigable acreage in the province is 1,500,000 acres.[1]

1. Acreage estimates by: Water Right Branch, Environmental Science and Licensing Division, Environmental Protection Service, Province of Alberta.

for the Province of Saskatchewan is not well developed. Preliminary indications are that sprinkler irrigation is not widely used in this province. There are 174,000 acres currently under irrigation in Saskatchewan. Deep wells and other underground water are not widely used in the province. However, the province has water reserved for an additional 247,000 potential irrigable acres.[2]

2. Acreage estimates by: Water Rights Branch, Water Management Service, Department of Environment, Province of Saskatchewan.

GARRISON DIVERSION UNIT [1]

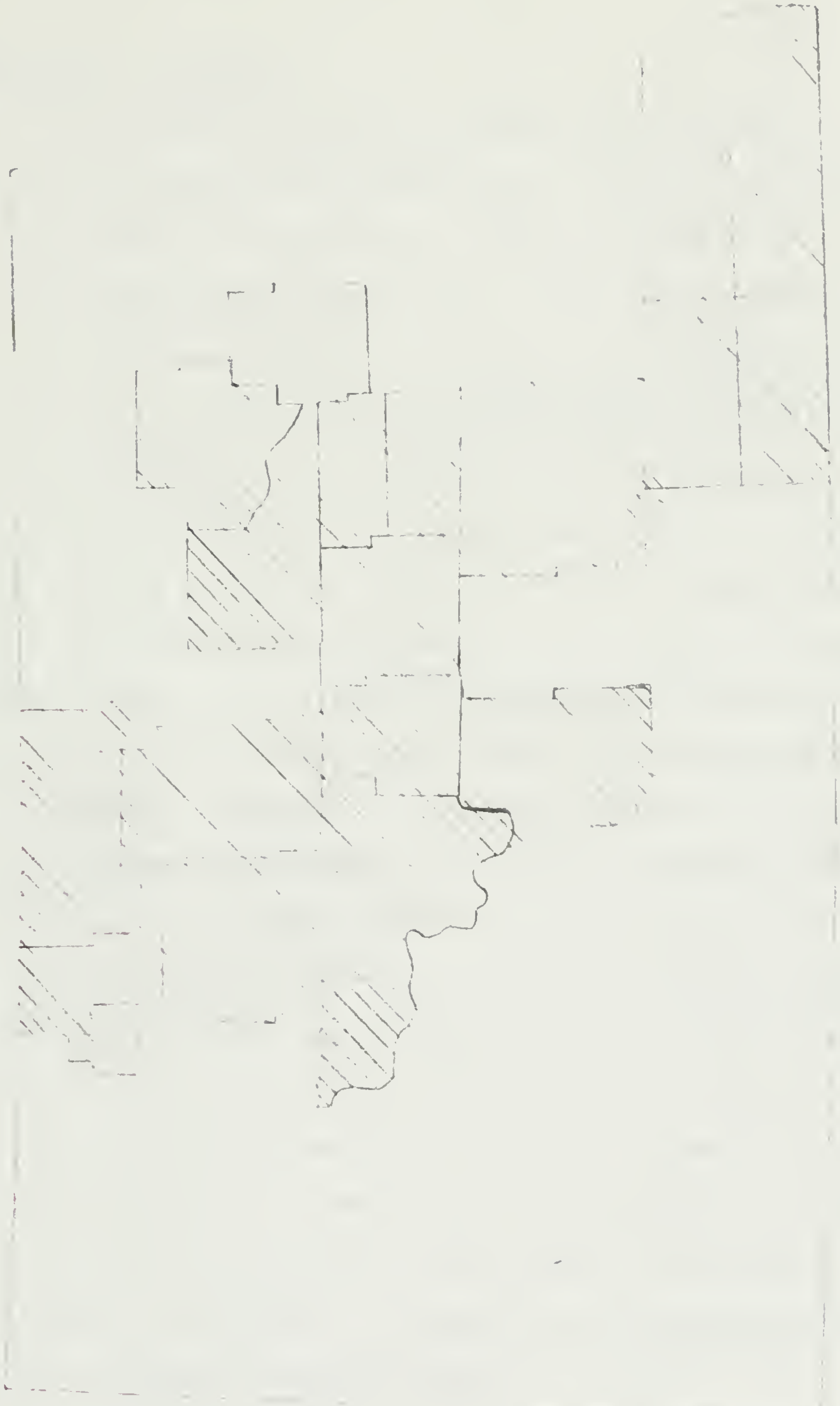


An adequate supply of water is available in most areas in the state of North Dakota to meet present and most future needs. In those areas where water does occur in insufficient amounts to meet the demand, plans are being made to overcome the deficiencies by diverting water from the areas possessing abundant supplies. At present, there is sufficient water available to meet demands of over 2,000,000 acres of irrigable land and to assure an abundant supply of water for industry and municipalities located in the proposed irrigable areas. The extensive groundwater supplies in the state are being catalogued so they too will be available for future needs. The gigantic Garrison Reservoir, which is approximately 65 miles northwest of Bismarck, impounds 24,000,000 acre-feet during flood stage. Approximately 14,000,000 acre-feet remain in the conservation pool for beneficial use.

1. State of North Dakota

MAP NO. 6

NORTH DAKOTA



PRINCIPAL NORTH DAKOTA COUNTIES TO BE AFFECTED BY GARRISON DIVERSION UNIT

MARKET POTENTIAL: A SUMMARY

In view of the fact that data on potentially irrigable acreage in the area under study come from a variety of sources and rest on a variety of assumptions, prudence dictates that market estimates should be conservative. Nevertheless, to err on the side of conservatism is as unrealistic as overestimation of market potential. Therefore the following data are presented in terms of low estimates and high estimates. Undoubtedly irrigable acreage eventually utilized will be greater than that indicated by the low estimates. As this study has endeavoured to point out, the relationship of water to soils, the costs of water transportation, and the economics of the agricultural market place in relation to water application costs will determine the levels of irrigation. Moreover, these same factors will dictate the type of irrigation technology utilized and, therefore, precise predictions as to type of system used are not possible. We do know, however, for the next two years in Montana at least, that for every ten acres planned for irrigation roughly 8.7 of them are planned for some type of sprinkler irrigation. We also know that nearly all the planned one quarter million acres in North Dakota's Garrison Project are designed to be sprinkler irrigated. Given the terrain and soil types of the Canadian provinces it is unlikely to expect that gravity irrigation will be anymore predominant than in Montana or North Dakota.

The following tables give relatively low and relatively high estimates of the potential acreage for development of sprinkler irrigation.

TABLE NO. 16

RELATIVELY LOW ESTIMATES OF POTENTIAL SPRINKLER IRRIGABLE ACREAGE IN THE STUDY AREA

MONTANA		ACRES
Yellowstone & Lower Missouri		870,890
Upper Missouri		15,000
Columbia Basin Drainage		4,000
NORTH DAKOTA, GARRISON PROJECT ONLY	ESTIMATED COMPLETION DATE	ACRES
Souris Section	1988	116,000
Oakes Section	1984	45,971
LaMoure Section	1982	13,350
Central North Dakota Section	1984	74,670
PROVINCE OF ALBERTA		ACRES
		127,500[1]
TOTAL LOW ESTIMATE		1,267,390

1. Estimated Alberta acreage using Montana's rate of 87.0% sprinkler irrigation for newly irrigated lands.

TABLE NO. 17

RELATIVELY HIGH ESTIMATES OF POTENTIAL SPRINKLER IRRIGABLE ACREAGE IN THE STUDY AREA[1]

MONTANA		ACRES
Yellowstone Drainage		637,500
Upper & Lower Missouri		500,000[2]
Columbia Basin Drainage		27,148[3]
NORTH DAKOTA	ESTIMATED COMPLETION DATE	ACRES
Garrison Diversion Unit	1988	250,000
Outside Garrison Project	1975	117,450
ALBERTA		ACRES
		1,275,000
SASKATCHEWAN		ACRES
		214,890
TOTAL HIGH ESTIMATE		3,021,988

1. Assumes Montana's rate of sprinkler development where 8.7 acres out of every 10 acres of newly irrigated lands are sprinkler irrigated.
2. This figure represents a doubling of the lower figures for the Missouri drainage. Given the potential for deep wells, the existing activity using wells, and the present and planned rate of development this is not an unlikely estimate.
3. This estimate is based on the data for 1974-75 in Montana's Columbia Basin drainage. During that two year period over 13,000 acres of new lands were brought under sprinklers. The figure estimated here is for development for four years at the 1974-75 rate. (See research note, page 53.)

TABLE NO. 18

POTENTIAL QUARTER SECTION SPRINKLER SYSTEM SALES IN STUDY AREA

TOTAL ACREAGE		NUMBER 160 ACRE UNITS
Relatively low estimated sprinkler acreage -	1,267,390	7,921
Relatively high estimated sprinkler acreage -	3,021,988	18,887

It is clear that a substantial market for sprinkler irrigation systems exists within Montana, Alberta, North Dakota and Saskatchewan. Gross acreage figures do not, of course, identify land mixes, ownership patterns, water transportation routes, etc. which will ultimately determine the number of sprinkler systems sold. Nor do these gross acreage figures indicate what portions of which markets local retailers will get and what portions a Montana or out of state manufacturer could expect to get. Additionally, the type of sprinkler sold in this area is primarily a matter of successfully marketing a product idea. During 1976-77 we do know that a little better than four of every 10 sprinkler systems planned are of the pivot type. Retailers of sprinkler equipment in Montana, for example, have told Consultants Collaborative that terrain, ownership patterns, soils and water characteristics indicate a ready market for smaller 40 acre type pivot systems. Too many unknowns are present to estimate the product configuration within this potential market. Experience in Oregon and Washington does indicate that aggressive sales practices, emphasis on service, product orientation to local conditions and attention to financing advantages can result in successful market penetration by even small sprinkler manufacturers.

In the Montana portion of the study area there is an additional market feature that requires emphasis. In an effort to provide

incentives to improve Montana's renewable resources the Montana Legislature enacted two laws that bear directly on the Montana sprinkler irrigation market. One law, creating an environmental trust fund from taxes on coal, provides low interest loans to farmers up to $100,000 for expenditures improving agricultural irrigation. The other law provides that new lands brought under irrigation will be taxed at the former dry land rate for the first three years following new irrigation installation.

TABLE NO. 19

SUMMARY OF MONTANA ARABLE LANDS

BUREAU OF RECLAMATION

ESTIMATED POTENTIAL BASED ON PROJECTS INVESTIGATED

Research Note: Since approximately 1950, several projects along Montana's river drainages have been investigated by the U.S. Bureau of Reclamation in conjunction with Montana water resource officials. The following table gives the irrigable acreage of the projects investigated during that 25 year period.

	NEW LANDS	
DRAINAGE	FULL SERVICE GRAVITY	FULL SERVICE SPRINKLER
COLUMBIA BASIN		
Clark Fork (without Knowles Dam)	247,091	60,669
Kootenai Basin	50,000	
TOTAL COLUMBIA BASIN (without Knowles Dam)	297,091	60,669
YELLOWSTONE BASIN	363,549	
LITTLE MISSOURI BASIN	21,000	
MISSOURI RIVER BASIN	737,078	
TOTAL STATE		
(without Knowles Dam)	1,418,718	60,669*
TOTAL FULL SERVICE WATER	1,406,375	
(with Knowles Dam)	1,491,740	
(without Knowles Dam)	1,490,140	

Source: Montana Water Resources Division

*These figures do not reflect the newer sprinkler irrigation technology.

MANUFACTURING SPRINKLER SYSTEMS IN MONTANA

INTRODUCTION

For purposes of this study the feasibility of manufacturing the circle or "center pivot" type sprinkler was undertaken. There are several reasons for this choice. Among the various types of sprinkler systems recent experience indicates that center pivots while initially more expensive than some other systems may have certain advantages in Montana. First, if manufactured in a local area, they can be made adaptable to local area conditions with a minimum of departure from basic design at the point of manufacture. Moreover, at this point in time, large manufacturers have not been capable of dominating the market to the extent that smaller manufacturers are ruled out. It is important to note also that plants of existing center pivot manufacturers tailored to market area conditions and service requirements might also find this market attractive.

The type of construction procedure and physical plant required to manufacture circle sprinklers is not so sophisticated or extensive as to require large capital outlays for plant construction. Additionally, the control of water application possible with center pivots, the low labor costs, their adaptibility to rough terrain and low infiltration soils make them technologically attractive to Montana, Alberta and North Dakota conditions.

Recent events in irrigation financing also make center pivots attractive. Interviews with members of the financial community serving agriculturists in Washington's Columbia Basin indicate that the advanced technology of center pivots has proven effective - - so effective, in fact, that all other factors being equal, loans for center pivot irrigation application are given precedence over other systems in that area. Also, a center pivot system is added to the value of the land when measuring appraised value for Federal Land Bank loans. Because center pivots meet the qualification of being "closely aligned with and usually sold as part of the real estate" they are considered an added value to the land itself for Federal Land Bank loan purposes. Other systems such as side rolls, tow lines, etc. do not. Just a few years ago only wells, pumps and power units were considered as adding value to the land.[1] This new development is of considerable importance because as Table No. 20 shows, the Federal Land Bank is a major source of farm credit.

Another major factor in selecting the center pivot for study over other systems is that the direction of sprinkler irrigation in Montana is very likely to be substantially toward irrigation of new lands. In Valley County, for example, new lands coming under development using deep wells during 1976-77 account for nearly 40,000 acres. Over half of this acreage which is planned

1. Interview with Mr. Fred Bemet, Senior Engineer Appraiser, Federal Land Bank of Omaha, Irrigation Age, October, 1975, p. 32.

TABLE NO. 20

COMPARISON OF FARM REAL ESTATE MORTGAGES RECORDED
BY THREE MAJOR LENDERS, U.S.A.

YEAR	TOTAL AMOUNT RECORDED	FEDERAL LAND BANK	INSURANCE COMPANIES	COMMERCIAL BANKS
1973	$19,485,552,000	46.4%	29.0%	24.6%
1974	$22,324,430,000	48.8%	26.7%	24.5%

Source: Federal Land Bank

for sprinkler irrigation will be under center pivot systems.[1] Moreover, in Montana of all lands under sprinkler irrigation through September of 1975, only 14% were under pivot sprinklers. However, during 1974-75, 45% of sprinkler irrigation expansion was pivots and projected plans for 1976-77 indicate that 43.6% of sprinkler irrigation expansion will be of the pivot type. Center pivots lend themselves readily to new lands development where soils are shallow, and terrain is irregular. And, experience in Washington's Columbia Basin indicates that where new lands of this type are developed under center pivots a fairly sizeable secondary industry concerned with design, and installation occurs. This secondary industry means additional jobs created. Indeed, in some cases, this secondary industry has developed to the point where large complexes of center pivot systems are maintained and operated by specialized firms under lease to the farmer-owner of the newly irrigated acreage. This secondary industry associated with large center pivot operation and installation could be a significant factor in improving the economic health of some Montana agricultural areas.

For these reasons, then, center pivot or circle type sprinkler system manufacture was undertaken for study.

1. Montana Rural Electric News, December, 1975, p.11.

LOCATING A CENTER PIVOT SYSTEM MANUFACTURING PLANT IN MONTANA

Three major factors are of importance in locating a center pivot manufacturing plant in Montana. They are: servicing the product; proximity to markets; and possible use of existing physical plant facilities.

Service: Service is especially critical if center pivot type automatic sprinklers are used. Automation is cheaper over the long run but because electric or hydraulic movers and control mechanisms on center pivots are sophisticated mechanical and electronic components, immediate service of equipment failure during growing seasons is imperative. Because it is imperative, the potential customer for an irrigation system is extremely sensitive to the availability of service accompanying the system he intends to purchase. It is for this reason that some pivot manufacturers say that a firm should serve no more than a 200 mile market radius. Research does indicate that a well developed sales and service organization with an acknowledged reputation can sell an irrigation system manufactured elsewhere and still dominate a local market. Nevertheless, it is clear that whether the manufacturer services the system or a local sales and service organization services the system, a reputation for service is the key to sales. And, moreover, the total area serviced must be small enough to enable the service organization to respond to service calls within

hours during the growing season. It is for this reason that smaller center pivot system manufacturers (150 - 400 unit sales per year) insist that a 100 mile to 200 mile radius is a maximum area to be adequately serviced by a manufacturer.

An example in Washington state may illustrate this point. A major midwest circle manufacturer has a factory branch sales and service organization in the southeast portion of Washington state headquartered in the Pasco area. Its major competitors in the area are located in Walla Walla, Othello and Eugene, Oregon. This major midwest manufacturer has a very low percentage of the total sales in the southwestern portion of Washington. However, just north of this area the same midwest manufactured circle system is sold by an <u>independent</u> sales and service organization which started in the irrigation systems business virtually at the beginning of the Columbia Basin Irrigation Project. This sales and service organization with an established, long-term reputation for service virtually dominated the northeast portion of the state selling the identical unit which the factory outlet fared poorly selling in the southwest portion of the state. The three smaller manufacturers who service their own products and who are located nearby are highly competetive. However, because they can service the area from the local factory service offices in a matter of hours and because the key to local factory sales is service, they

dominate that market over the larger more well-known product line of the factory outlet.

The implications for a manufacturer in Montana are clear. The location of a plant must be such that a market sufficient to warrant manufacture is present and the market area must be capable of being serviced within a matter of hours. If the manufacturer establishes sales and service organizations the matter of service remains critical. And, given the geography of the area under study, a plant or plants located in Montana might have significant advantages in this connection.

PROXIMITY TO MARKETS AND EXISTING PHYSICAL PLANT FACILITIES

As has been noted above, South Dakota is not a highly probable market for a sprinkler manufacturing firm located in Montana. North Dakota is a probable market. This depends, to a great extent on the ultimate completion of the Garrison Diversion Unit and the incremental completion of the various sections as the project moves toward completion. Table No. 21 shows comparative distances to two North Dakota points from Valley, Nebraska, a sprinkler irrigation manufacturing center, and Glasgow and Billings, Montana. The two North Dakota points lie roughly at each end of the large crescent formed by the proposed Garrison Diversion Unit.

TABLE NO. 21

MILAGE TO POSSIBLE MARKETS

POINT OF DEPARTURE	DESTINATION	MILAGE
Valley, Nebraska	Fargo, North Dakota	527 miles
Valley, Nebraska	Minot, North Dakota	699 miles
Glasgow, Montana	Fargo, North Dakota	550 miles
Glasgow, Montana	Minot, North Dakota	252 miles
Billings, Montana	Fargo, North Dakota	620 miles
Billings, Montana	Minot, North Dakota	530 miles

Center pivot sprinkler irrigation manufacture has begun in Calgary, Alberta and some U.S. sales and distributorships have been started in Alberta. Nevertheless, if a manufacturer of

center pivots was located in Montana, the Alberta market would be closer to the Montana manufacturer than to any other U.S. based firm.

Within Montana recent and planned major installations of pivot type systems have occurred in certain areas. Map No. 7 shows these areas by county where 1,000 acres or more have recently gone under pivots or are planned for pivots by 1977. These 13 counties are clustered in roughly four areas.

From Soil Conservation Service data it is clear that where pivots have been installed in the recent past there is high likelihood that additional units are planned in the same area for the future. This indicates a pattern of acceptance by farmers typical of that experienced in Oregon and eastern Washington where pivot systems have recently been introduced. A manufacturing plant site located in or near these high activity areas seems a good choice.

Given the considerations of proximity of markets outside Montana, in Montana and, existing physical plants, two Montana locations stand out as priority choices for plant sites. The first of these is the Glasgow Industrial Community at the former Glasgow Air Force Base 18 miles from Glasgow, Montana in Valley County. Recent negotiations by a local development corporation, the State of Montana and the Air Force have resulted in the creation of an

industrial park at the former base that makes the Glasgow Industrial Community a viable candidate for industrial expansion. Glasgow is in the heart of considerable Montana sprinkler irrigation activity, and it is close to North Dakota markets. (See Table No. 20.) Glasgow is only 354 miles from the center of the 74,670 acre central North Dakota section of the Garrison Diversion Unit and only about 260 miles from the center of the 116,000 acre Souris Section of the same project. And, Glasgow is less than 70 miles from the Saskatchewan border and about 200 miles from the western border of Alberta.[1]

Another existing site located near areas of increasing sprinkler irrigation activity is at Conrad, Montana. This site is within 40 miles of the Alberta border on U.S. 91 and approximately 200 miles from Calgary, Alberta. Like Glasgow, Conrad sits on the main east-west Burlington Northern line. The Economic Development Corporation of Pondera County at Conrad is developing a former Air Force Anti-Ballistics Missile site as an industrial park. The physical description of the site is as follows:

<u>Conrad Industrial Site Specifications:</u>[2]

305.8 acres.

Nine miles east of Conrad, Montana on wide, paved road.

H-shaped office building consisting of two 36' x 218' wings with 66' x 60' connecting structure. Total area is 19,656 sq. ft. Paved and curbed parking lots.

1. For a detailed description of this industrial community see "The Glasgow Industrial Community, Hub of Northeastern Montana - An Economic Profile", attached.
2. Economic Development Corporation of Pondera County.

45,600 sq. ft. warehouse. Butler Steel building on reinforced concrete, 24 ft. wall height. Office space 20' x 120' and 12' x 16'. Insulated. Gas fired heaters. Fluorescent lighting. Overhead conveyor system installed. Ready for occupancy.

5,980 sq. ft. Butler Steel building. Insulated and gas heated. Fluorescent and mercury vapor lighting. 12' x 20' office. 9' x 24' tool room. Two overhead steel doors. Overhead conveyor system installed.

4,600 sq. ft. Butler Steel building. Overhead steel doors. Ready for occupancy.

Additional smaller structures located on site. On site water storage system with pipeline from Tiber Reservoir.

Electricity from Montana Power, natural gas line, sewage system, and telephone service.

Custom plant locations available.

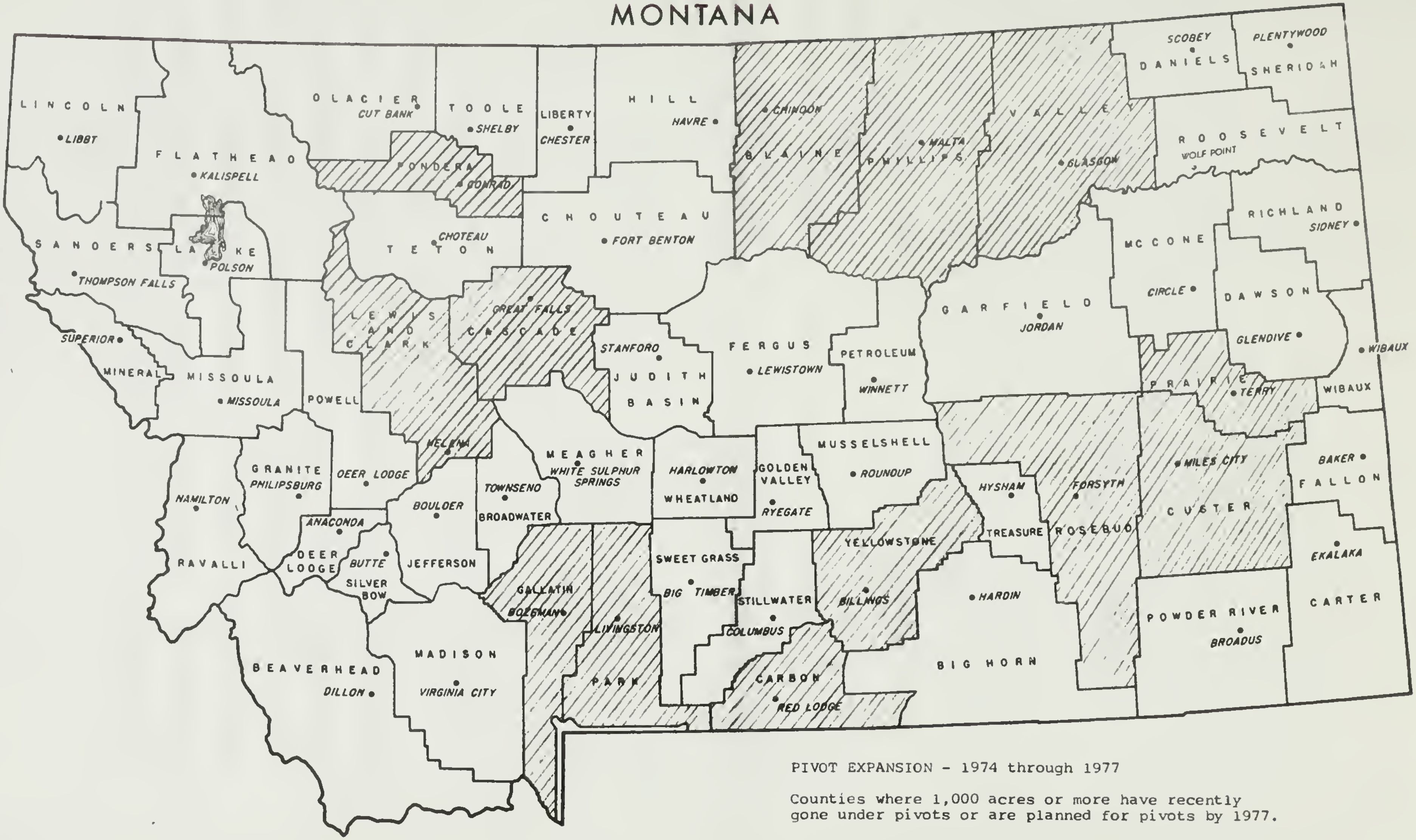
Parking and outdoor storage areas.

In the more or less southern half of Montana two centers of pivot irrigation are underway. One such center is the Gallatin and Park County area (see Map No. 8). Extensive sprinkler irrigation has also been undertaken in Madison and Beaverhead Counties but center pivots have thus far not been as popular. In the south-western area both Livingston and Bozeman seem possible choices for a plant location if consideration is given to service radius requirements as previously discussed.

Farther to the east, Yellowstone, Carbon, Rosebud, Custer and Prairie Counties (see Map No. 8) have also seen considerable center pivot activity and additional installations are planned.

MAP NO. 7

MONTANA



PIVOT EXPANSION - 1974 through 1977

Counties where 1,000 acres or more have recently gone under pivots or are planned for pivots by 1977.

Fold to here to fit standard binder

In the eastern area Forsyth or Miles City are close to both Montana activity and projected North Dakota activity, particularily the central North Dakota section and the Souris Section of the Garrison Diversion Unit.

Location of a plant in Montana must, of course, depend on a number of factors but four factors should be carefully considered. One factor previously mentioned is related to servicing center pivot customers from the factory.

A second consideration is the transportation costs. Moving a 130 acre center pivot to the erection site costs approximately $1.00 per loaded mile. This means, for example, that a center pivot manufactured in Nebraska and trucked to Great Falls, Montana has a freight cost of nearly $1,000. If a plant is located in the heart of a market area and close to adjacent market areas, there can be an advantage in lowering costs of sales due to freight rates alone. It is notable in this regard that shipment of center pivots to Canada is duty free.

Sources of raw materials -- steel and pipe -- are Seattle, Portland, Minneapolis and Calgary, Canada. Costs of raw materials vary widely from month to month and most manufacturers in the Montana area do some shopping but tend to make purchses where supplies seem assured during periods of shortages. Transportation costs for raw materials do not place Montana at any particular

disadvantage. Indeed, the availability of pipe and steel in Calgary, Alberta even with the small duty may be an advantage to a firm locating a plant at Glasgow or Conrad.

The existence of buildings with characteristics adaptable to center pivot manufacture at Conrad and Glasgow could be an advantage in lowering start up costs for a firm deciding to locate at either of these sites.

CASH FLOW

The following financial analysis is for a firm located in Montana producing and selling the following number of 130 acre center pivot systems.

Year		Sales
1	Start Up	25
2		110
3	2 shifts	180
4	2 shifts	200
5	2 shifts	220

If a firm were to start up in Montana in 1976 they would have a potential market of 340 units in Montana alone during 1976-77. Given the pace of sales in Oregon and Washington and the present pace in Montana a firm producing center pivots in the quantities projected over the five year period for the market area could expect sales at this magnitude or better over that five year period.

The analysis assumes that a building would be built or leased with a mortgage or lease payment amounting to approximately $1,000 per month. The lease payment in the cash flow analysis is based on the rate at the Conrad Industrial Site.

Inventory and property taxes were computed at the new Montana industrial incentive rates.

The firm would employ approximately 50 to 60 employees at year five in the projected period.

(For detailed data see the Explanatory Notes following the cash flow analysis.)

The sales price of each unit in the analysis is $33,000 and assumes that the unit is sold by the manufacturer. It is also assumed that the unit is painted rather than epoxied or galvanized. Epoxy or galvanize coatings would raise the cost of each unit by approximately $1,300. Some major manufacturers offer a choice of coatings. The nearest epoxy plant is Walla Walla, Washington.

SPREAD SHEET

	1st YEAR I	II	III	IV	2nd YEAR I	II	III	IV	3rd YEAR	4th YEAR	5th YEAR
EXPENSES:											
Personnel Costs	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 680,000	$ 680,000	$ 680,000
Materials	556,400	556,400	556,400	556,400	1,985,600	0	0	0	3,971,200	3,971,200	3,971,200
Insurance	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	6,000	6,000	6,000
Lease	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	12,000	12,000	12,000
Equip. Loan Interest	1,998	1,916	1,833	1,747	1,659	1,567	1,477	1,382	4,480	2,790	1,250
Equip. Depreciation	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	12,000	12,000	12,000
Utilities	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	61,200	61,200	61,200
Advertising & Marketing	9,000	7,500	6,000	6,000	6,000	6,000	6,000	6,000	48,000	48,000	48,000
Transportation	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	40,000	40,000	40,000
Building Maintenance	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Legal & Bookkeeping	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	18,000	18,000	18,000
Inventory Tax	553	553	533	553	3,738	3,738	3,738	3,738	13,930	17,260	17,260
Property Tax	143	143	143	143	128	128	128	128	457	857	734
Misc.	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	10,000	10,000	10,000
TOTAL EXPENSES	$ 685,594	$ 684,012	$ 682,429	$ 682,343	$2,114,625	$ 128,935	$ 128,843	$ 128,748	$4,878,767	$4,880,807	$4,879,144
	Avg. $683,594/$32,000 = 22 units										
SALES - UNITS	0	3	7	15	20	25	30	35	180	200	220
TOTAL INCOME	0	$ 96,000	$ 224,000	$ 480,000	$ 700,000	$ 875,000	$1,050,000	$1,225,000	6,300,000	7,000,000	7,700,000
NET PROFIT BEFORE TAX	(685,594)	(588,012)	(458,429)	(202,343)	(1,414,625)	746,065	921,157	1,096,252			
ANNUAL NET PBT				(1,934,378)				1,348,849	1,421,233 Carry Forward (585,529) 835,704	2,119,193	2,820,856
TAX - Montana				50				50	5 3/4% 48,053	6 3/4% 143,046 1,976,147	190,408 2,630,448
TAX - Federal				0				0	371,558	942,051	1,256,115
NET PROFIT				(1,934,422)				1,348,799	416,093	1,034,096	1,374,333
PLUS DEPRECIATION				12,000				12,000	12,000	12,000	12,000
CASH FLOW				(1,922,422)				1,360,799	428,093	1,046,096	1,386,333
LESS PRINC. PAYMENT				14,925				16,332	17,940	19,630	21,170
ADJUSTED CASH FLOW				(1,937,347)				1,344,467	410,153	1,026,466	1,345,163
CUMULATIVE CASH POSITION								(592,880)	(182,727)	843,739	2,188,902

The financial analysis contained in this study is based on two major assumptions. First, the rate of development in the market area would only justify a very large volume firm if that firm expected to capture virtually the entire area market. A second assumption is that a new firm could be established and be profitable with a sales volume adjusted to present realistic estimates of sales and grow as the market grows.

Given the diversity of irrigation equipment requirements two important points should be stressed in this generalized treatment of the market area. First, only one type of sprinkler system manufacture has been discussed in detail - - center pivots of the quarter section size. Other systems are and will be used in Montana and the irrigation industry would do well to consider this market for possible manufacture of other system types. Secondly, from interviews within the market area among people close to sprinkler irrigation, it is apparent that there is a large potential market for the more specialized smaller acreage center pivot systems now on the market.

One thing is abundantly clear. Within the market area covered by this study, the single most important economic phenomenon in agriculture over the next 15 to 20 years will be sprinkler irrigation.

EXPLANATORY NOTES

APPENDIX NO. I

PLANT SPECS.

Manufacturing Plant	Sept., 1970[1]		Approx. July, 1976[2]
200' x 80'	$8.18/sq. ft.	$130,880	$216,000
Office & Warehouse			
50' x 80'	$11.96/sq. ft.	$ 47,840	$ 79,000
		TOTAL PLANT	$285,000

1. Source: Dodge Building Cost & Specifications Digest, McGraw-Hill Information Systems Company, 1970.

2. Construction Cost Indexes (Construction Review, Vol. 21, No. 7, August 1975, Table E-1, p.61)

	Sept., 1970	July, 1975
Dept. of Commerce - composite	123	191.3
American Appraisal Co.	127	191
Doecke - Commercial & Factory	126.8	190.1
AVG.	125.6	190.8

Increase 51.9%, 9% per year

Note: Assuming sample $250,000 building was purchased in 1974, its replacement value in 1976 would be about $300,000.

Helena Airport Industrial Park:

No paving (10 acres)	$.10/sq. ft.	$45,000
(5 - 6 acres)		$25,000

Note: Compares to 6 acres at $4,000/acre reported by sample.

Lease: Conrad Industrial Park:

$.50/year - heat $.25/year - lease incl. taxes	45,600 sq. ft. $.50/sq. ft./mo.	Bldg. Modif. Welders	$10,000 $30,000

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$.50/sq. ft./mo.

Bldg. Modif. $10,000
Welders $30,000

PLANT FINANCING

Building (including welders) & Land	$325,000	
Downpayment $.25 x $325,000 = $81,250		
Monthly payment 8%, 20 years (assuming SBA 5½% 1st 50,000; 8½% balance)		$2,321
Equipment - Forklifts $60,000; Painting $30,000		
Downpayment $.33 x $90,000 = $30,000		
Monthly Payment 9%, 5 yrs.		1,246
MONTHLY COSTS		$3,567
TOTAL DOWN		$111,250

Utilities

12 welders	$650/mo. electric
heat, lights, water	650/mo.
	$1,300

Forklifts	$60,000
Painters	30,000
Welders	30,000
	$120,000 - 25% down $30,000

$90,000, 9%, 15 yrs. $1,868.3

MATERIALS COST

Single 130 acre system, 10 spans (100 units)

TOTAL	$14,300 - $14,500 per unit	
Framing Steel, 16,000 lbs.	$ 5,525	
Pipe, 1,300 ft., 6 5/8" @ $1.75/ft.	2,275	
Control & Wiring	2,500	
Motors - Alabama	1,400	
Drive - Alabama	2,000	
Tires & Wheels	800	
Epoxy Coating	1,600 - 1,700	Choice of 1 Coating Process
Galvanize Coating	1,600 - 1,700	
Paint Coating	300	
	$16,200 per unit	

Note: 12% reduction for 400 unit production.

Assume 15% increase for orders in 25 unit lots.

Material	$18,600	$16,200
Shipping	3,656	3,656
	$22,256	$19,856
	x 25	x 100

PERSONNEL

	Per Mo.
President	$ 1,800
Plant Mgr.	1,500
Mkt. Mgr.	1,500
Foreman - 2 @ $1,200	2,400
Welder	
Sidney $4.84 Union Scale ($2.50 other)	
12 @ $5.50 hr. = $950/mo.	11,430
Painters	
Sidney $3.00 - $8.00 hr.	
2 @ $5.00/hr. = $870/mo.	1,730
Truck Drivers	
Glasgow $3.00 - $4.50/hr.	
Sidney $25.00 - $30.00/day	
2 @ $5.00/hr = $870/mo.	1,730
Laborers	
7 @ $3.00/hr. = $520/mo.	3,640
	$25,730

	5.85% FICA	Work. Comp.	Unemployment[1]	
Pres.	$ 74.60	$ 7.20	$ 8.00	
Mgrs.	149.20	12.00	16.00	
Foremen	140.40	120.00	16.00	
Welders	668.65	400.05	96.00	
Painters	101.20	163.48	16.00	
Truck Drivers	101.20	86.50	16.00	
Laborers	212.94	182.00	56.00	
	$1,448.19	$ 971.23	$ 200.00	$2,619.42

1. 2% on first 4,800

BREAK EVEN

Personnel	$25,730	
Employer's Expense	2,620	
Insurance - Liab. & Contents	$28,350	
Insurance - Liab. & Contents 6,000	500	
Bldg. - Maint. & Supplies	500	
Utilities - Welders $650/mo.	1,300	
Heat $.50/sq. ft./yr. x 45,000	1,900	$3,500
Light	300	
Double Shift - Welders $650/mo. x 2 $2,600 Heat, same $1,900 Light $300/mo. x 2 $600		$5,100
Inventory Tax, 7% Taxable Value		
170 mills (x .00476)	Inventories as of Jan. 1 first year	
Lease	950 + $50/mo. office equip. lease	
Mortgage, Equipment	1,870	
Depr., 10 yr. S.L.	1,000	
Adv. & Marketing	2,000	
Transportation	1,650	
Legal & Bookkeeping	1,000	

Materials Cost Per Unit	16,200
Shipping Steel $1.60/cwt x 16,000 lb.	256
Other $10.00/cwt x 34,000 lb.	3,400
	$ 19,856

Break Even: $\$30,000\,x = 20,000 + 50,000 \quad x = \frac{50,000}{10,000} = 5$